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which the numerous and varied animal types can be made to fall into any evolutionary plan is to consider the radially symmetrical colonial cœlenterates as representing the highest degree of purely biological perfection, and all other animals (except the sponges which are their equivalent) as derived from them through the appearance of various defects which had the anomalous result of leading to increased bodily efficiency.

THE CORRELATION OF TIME UNITS AND CLIMATIC CHANGES IN PEAT DEPOSITS OF THE UNITED STATES AND EUROPE

BY ALFRED P. DACHNOWSKI

U. S. DEPT. OF AGRICULTURE, WASHINGTON, D. C.

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This paper is a continuation of a previous publication[4] which contained a discussion of the evidence in peat deposits of the United States regarding climatic changes since the last Ice age.

For purposes of comparison a brief account in tabular form is presented to show certain correlations between peat deposits in this country with those of the continent of Europe.

1. A correlation of American with European *glacial drift sheets* has been made by Leverett.[8] By considering with Leverett the early and late Wisconsin Glaciation contemporaneous with the Würm glaciation it is possible to correlate the corresponding minor glacial stages.

The three readvances of the ice sheet that produced the morainic systems of the late Wisconsin: the Valparaiso-Kalamazoo, Lake Border, and Port Huron may be regarded as corresponding to Penck and Brückner's[10] cycle of mountain glaciations of the Alps: the Bühl, Gschnitz, and Daun-stadia—and to those of the Scandinavian continental ice-fields: DeGeer's[7] Dani-, Goti-, and Fini-glacial stadia.

2. *The Stratigraphic Study of Peat Deposits* in the United States has furnished valuable data as to the botanical composition of types of peat and their economic value. It has been shown also that the material formed under wet conditions differs in botanical composition and texture from that formed during dry periods, and that the study of separate and distinct layers in deposits formed within the main morainic systems during the glacial retreat serves to throw much light on the character of the past climatic changes.

Evidence is now presented by means of the position of conspicuous layers of forest peat, fibrous sedge and reed peat, and colloidal peat, to show the equivalence of peat deposits which were formed in the respective morainal belts of the United States and Europe. The greater structural complexity, it will be noted, is confined to areas within the oldest of the morainic

systems, while within the later and more recent positions of the ice border the deposits are younger in age and consist of only a few layers of peat. The lack of structural diversity in the uppermost layers of the older deposits is related probably to the distance of those deposits from the direct climatic influence of the later glacial sub-stages.

TABLE I

CORRELATION OF GLACIAL, CLIMATIC, AND LIFE STAGES SINCE THE LAST ICE-AGE IN THE UNITED STATES

GLACIAL SUB-STAGES	GREAT LAKES STAGES	CLIMATIC CHANGES	ESTIMATED TIME	ANIMAL REMAINS	HUMAN REMAIN	VEGETATION SUCCESSION
8. Present	Lake Michigan 580 ft.		A.D.			Forest Spagnum bogs and marsh
7. Recent (post-glacial)	Post-Nippissing	Rising dry	—o— B.C.			
						Forest
6. Port Huron	Nippissing 530–590 Champlain Sea, Niagara Algogum 608–609	Temperate, humid	7000–5000 B.C.		Mound builders?	Marsh
morainic system	Lundy-Duluth 615 ft.	Temperate		Mastodon		
		Dry				Forest
5 Lake Border	Whittlesey-Chicago-Saginaw	Cool, humid			Flint implements	Marsh
morainic system	Maumee 805 ft.	Warm, dry	11000–8000 B.C.			
						Forest
4. Valparaiso	Late Wisconsin drift	Warm, humid	18000–16000 B.C.	Mastodon		Marsh
Kalamazoo morainic system	Loess formed	Cool, windy, dry				Steppe?
		Temporary amelioration				Low shrubs?
3. Bloomington		Cold, humid	25000 B.C.			
morainic system 2. Shelbyville moraines		Cold	28000 B.C.			Tundra?
1. Wisconsin driftborder		Arctic	35000–30000 B.C.			

To the practical worker it is obvious that a better understanding of the structural differences in peat deposits implies a more correct estimate of their economic value.

The profile sections visualize the stratigraphic relationship of American and European peatland and they suggest the value of a more detailed

TABLE II

STRATIGRAPHIC FEATURES OF PEAT DEPOSITS IN THE U. S.

	I	II	III	IV	V	VI	VII	VIII	IX	X
	CANTON, OHIO	KENT, OHIO	KANKAKEE, IND.	DISMAL SWAMP, VA.	EVERGLADES, FLA.	MANTUA, OHIO	FREDMONT, IND.	SANILAC, MICH.	ROME, N.Y.	CHASSEL, MICH.
8.	Sedge	Forest + Sphagnum	Forest + Macerated	Forest + Macerated	Sedge + Macerated	Forest	Sedge + Macerated	Shrub	Forest + Sedge	Forest + Sphagnum Sedge
7.	Sedge							Sedge		
	?	Sedge	Sedge-Reed	Forest	Sedge	Forest	Colloidal	Forest	Forest	Forest
	Sedge + Hypnum	Macerated	Sedge Macerated	+ Macerated	+ Macerated		+ Macerated	Sedge	Hypnum	
								Macerated		
	Sedge	Forest	Shrub + Sedge	Forest	Sedge	Forest	Colloidal			
5.	+ Hypnum	Sedge	Sedge	+ Macerated	+ Macerated	Sedge	+ Macerated Sand			
						Macerated	Macerated			
	Reed	Forest	Forest	Forest	Sedge					
4.	Macerated Clay	Sedge Macerated								
	Macerated									
3.										
2.										
1.										

study of peat utilization in Europe in order to determine the best practices necessary to a successful solution of the peatland problem in this country on related peat deposits.

3. The common *time* relationship is confirmed by a series of correlations. It is based on the similarity between the groups of morainal systems as the great, basic divisions of time, and on the loess deposits resting upon the

TABLE III

CORRELATION OF GLACIAL, CLIMATIC, AND LIFE STAGES SINCE THE LAST ICE-AGE IN EUROPE

GLACIAL SUB-STAGES	BALTIC LAKE STAGES	CLIMATIC CHANGES	ESTIMATED TIME	ANIMAL REMAINS	HUMAN* REMAINS	VEGETAION SUCCESSION
8. Present	Baltic o. m.	Rising, dry, cool, moist	A.D. —o— B.C.			Forest
7. Recent (Post-glacial)			1800 B.C.–300 A.D.		Iron age	Younger sphagnum bogs
		Warm, dry	3000–1800 B.C.			Forest Heath (beech, fir)
	Litorina sea	Warm, moist	4000–3000 B.C.		Shell heaps	Older
6. Daun	0–22 m.		7000–5000 B.C.		Neolithic	sphagnum
Fini-glacial		Continental			culture Lake dwellers	bogs
					Azilian	Forest (oak)
5. Gschnitz			10000–8000 B.C.		Paleolithic	
Goti-glacial	Ancylus Lake 66–175 m.				culture	Marsh
						Forest (birch, pine)
4. Bühl		Severe Continental	18000–16000 B.C.	Steppe horse	Magdalen	Marsh Steppe
Dani-glacial	Yoldia sea 300 m.	Loess formed		Reindeer	culture	Dryas Steppe
		Temp. amelioration, Warm, arid				Low shrubs (Aspen willow)
3.				Mammoth Reindeer	Solutrean	Sub-arctic
2.					culture Aurignacean	Tundra
1. Wurm drift border		Arctic	30000 B.C.		culture	

*Data taken in large part from Osborn (9)

Mousterian culture

moraines of the Würm-Bühl interstadium and the early Wisconsin drift, on the glacial lake stages of the Great Lakes and the Baltic, on the series of climatic changes, and on the remarkable association of the layers of peat material in the deposits which are referable to the same glacial substage; they mark the lesser divisions of time in the different geographic regions. These events were not local phenomena but well-marked stages

which occurred nearly simultaneously over a large part of northern America and northern Europe. The combined evidence suggests that it is possible to date with fair exactness the general course of events since the last Ice-age. This chronology may furnish important data bearing on different branches of science.

(*a*) The estimate on the duration of Post-Wisconsin glacial time in the United States is based chiefly on the recession of the waterfalls of the Niagara. The figures for the larger subdivisions fall within the estimates made by Reeds,[12] Coleman,[3] Taylor,[8] Chamberlain and Salisbury[2].

TABLE IV

PROFILE SECTIONS FROM PEAT DEPOSIT OF EUROPE

	XI	XII	XIII	XIV	XV	XVI	XVII
	GERMANY	ENGLAND	AUSTRIA ALPS	SWEDEN	SWEDEN	RUSSIA	RUSSIA
8.	Sphagnum	Top removed	Forest		(Forest)	(Forest)	(Forest)
7.		+ Sphagnum	+ Sphagnum	Sphagnum	+ Sphagnum	+ Sphagnum	+ Sphagnum
	Heath	?	Shrub forest	Forest shrub	?	Forest	Forest
6.	Sphagnum	Sphagnum	Sphagnum	Sedge-Reed	Sphagnum	Sedge	Sphagnum
	Sedge or						Hypmum
	Forest shrub	Forest	Forest	Reed	Forest shrub	Forest	Reed
5.							Sedge
	Sedge + Reed	Sedge + Reed	Reed	Macerated	Sedge	Macerated	
					Macerated		
	Reed or forest	Reed and drifted timber	Reed	Macerated			
4.	Macerated	Hypnum	Hypnum				
	Macerated	Macerated					
3.							
2.							
1.							

(*b*) The time units of measurement of Penck,[10] DeGeer,[7] Wahnschaffe[15] and Brooks[1] are more or less similar with the dates delimiting the American stages.

4. The correlation of past *climates* in the United States with those of the European last glacial period has not been worked out on a meteorological basis but there is sufficient information at hand of considerable interest for comparison with the conclusions based on European evidence.

The results of the correlation agree in showing that, although the evolution of climate has been continuous, there have been several climatic waves since the last glacial period, each of relatively long duration. The climatic pulsation, resembling a climatic belt, consisted of a cold and humid period bordering the glacial readvance, followed by a warmer, drier period

in the accompanying interstadial time, with a tendency toward optimum conditions which favored the growth of forests. It is quite probable that the last climatic wave or belt, possibly in diminishing intensity, continues to shift northward at the present time.

5. In the past sixty centuries the power of nations has been moving rather steadily northward, and the higher production of agricultural crops has occurred in general near the northern limits of distribution. It is significant that this northward tendency in agricultural and social development seems to be continuing and that it appears to be correlated with practically the same course of events which is shown in Tables I to IV.

PROFILE SECTIONS OF PEAT DEPOSITS

I, II, VI and VII from *Botanical Gazette*,[5] **72,** 57–89, 1921. (4)

III. Profile of Kankakee Marsh near Crumstown, Indiana.

IV. Cross Section of Dismal Swamp, Virginia, generalized from soundings and exposures along the feeder ditch and the Dismal Swamp canal.

V. Cross section of Torry Island in Lake Okeechobee, Florida, also near Okeelanta, about five miles south from the lake shore.

VIII. Sounding on peat experiment sub-station near Sanilac, Michigan.

IX. Profile along barge canal near James street bridge at Rome, N. Y.

X. Sounding in central location of peat deposits at Chassel-Klingville, Michigan.

XI. After Weber. (16) XII. After Rankin. (11)

XIII. After Shreiber. (14) XIV. After Sernander. (13)

XV. After Erdtman. (6) XVI, XVII. After Docturowski. (5)

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THE SPECTRAL ENERGY DISTRIBUTION AND OPACITY OF WIRE EXPLOSION VAPORS

BY J. A. ANDERSON

MOUNT WILSON OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

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It has been shown[1] that a fine wire, through which is passed the discharge of a large high voltage condenser, vaporizes so rapidly that the phenomenon is best described as an explosion. The actual time required for the wire to pass from the solid to the vapor state is probably less than one millionth of a second. If the explosion is made to take place in the space between two parallel planes from 2 to 3 millimeters apart, such as a slot in a block of wood, its spectrum is continuous, the lines of the metal exploded appearing as absorption lines. The maximum intensity of the light is very great, being of the order of that to be expected from a black body at a temperature of about 20,000° K.

A preliminary study of the spectral energy distribution given by the explosion of iron wires has been made, using a quartz spectrograph with a vacuum thermo-couple[2] and galvanometer. The value of $E\lambda d\lambda$ increases very rapidly from the infra red to about $\lambda 4300$; from this point to the ultra violet the great groups of iron absorption lines cause the values of $E\lambda d\lambda$ to oscillate considerably but its general tendency is upwards and the highest values are reached between $\lambda 2600$ and $\lambda 2150$. From $\lambda 2150$ to $\lambda 1990$ the values fall off rapidly, in part, perhaps, due to the absorption of the quartz lenses and prisms, and to that of the air.

Spectrograms of the explosions of the following metals have been made using a one meter focus grating spectrograph: copper, silver, gold, magnesium, zinc, cadmium, aluminum, tin, lead, tungsten, iron and nickel. All of these give continuous spectra of the same general intensity most of them appearing rather more intense than iron on account of the numerous absorption lines of the latter. Copper, silver and gold are anomalous in that the pure wires of these metals will not explode properly when placed in a slot in a block of wood, the main discharge always seeking a path around the